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REALTEK

REALTEK RTL8922AE Combo Module

General Description

- The Realtek RTL8821AE is a highly integrated single-chip 802.11b/g/n/ac 1T1R WLAN PCI Express network interface controller with integrated Bluetooth 2.1/3/0/4.0 USB interface controller. It combines a WLAN MAC, a 1T1R capable WLAN baseband, BT Protocol Stack (LM, LL, and LE), BT Baseband, modem, and WLAN/BT RF in a single chip. The RTL8821AE provides a complete solution for a high throughput performance integrated wireless LAN and Bluetooth device.

- The RTL8821AE WLAN baseband implements Orthogonal Frequency Division Multiplexing (OFDM) with 1 transmit and 1 receive path and is compatible with the 802.11ac specification. Features include one spatial stream transmission, short guard interval (GI) of 400ns, spatial spreading, and transmission over 20MHz , 40MHz and 80MHz channel bandwidth.

- For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK) and OFDM baseband processing are included to support all 802.11b and 802.11g data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability, are available, and CCK provides support for legacy data rates, with long or short preamble. The high-speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, 64QAM and 256-QAM modulation of the individual subcarriers and rate compatible punctured convolutional coding with coding rate of 1/2, 2/3, 3/4, and 5/6, provide up to 433.3Mbps for 802.11ac OFDM.

- A RTL8821AE built-in enhanced signal detector, adaptive frequency domain equalizer, and a soft-decision Viterbi decoder help to alleviate multi-path effects and mutual interference in the reception of multiple streams. Robust interference detection and suppression are provided to protect against Bluetooth, cordless phone, and microwave oven interference.

- Efficient IQ-imbalance, DC offset, phase noise, frequency offset, and timing offset compensations are provided for the radio frequency front-end. Selectable digital transmit and receive FIR filters are provided to meet transmit spectrum mask requirements and to reject adjacent channel interference, respectively.

- The RTL8821AE WLAN Controller supports fast receiver Automatic Gain Control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control function to obtain better performance in the analog portions of the transceiver.

- The RTL8821AE WLAN MAC supports 802.11e for multimedia applications, 802.11i for security, and 802.11n/802.11ac Draft 2.0 for enhanced MAC protocol efficiency.

Using packet aggregation techniques such as A-MPDU with BA and A-MSDU, protocol efficiency is significantly improved. Power saving mechanisms such as Legacy Power Save, and U-APSD, reduce the power wasted during idle time, and compensate for the extra power required to transmit OFDM. The RTL8821AE provides simple legacy and 20MHz/40MHz/80MHz co-existence mechanisms to ensure backward and network compatibility.

- The RTL8821AE Bluetooth controller complies with Bluetooth core specification v4.0, and supports dual mode (BR/EDR + AMP + Low Energy Controllers). It is compatible with previous versions, including v2.1 + EDR and v3.0 + HS. For BR/EDR, it supports scattered topology and allows four active links in slave mode, and seven active links in master mode. For Low Energy, it supports multiple states and allows eight active links in master mode. The links in BR/EDR and LE can be active simultaneously.

Product specifications

Environmental

Operating

- **Operating Temperature:** -20 to 70 C
- **Relative Humidity:** 5-90% (non-condensing)

Storage

- **Temperature:** -55 to 125 C
- **Relevant Humidity:** 5-95% (non-condensing)

Functional Specifications

Table 1. Functional Specifications

Standards	**WiFi:** IEEE 802.11a/b/g/n/e/i/h/k/r/draft-ac **BT:** V2.1+EDR/BT v3.0/BT v3.0+HS/BT v4.0
Bus Interface	**WiFi:** PCI Express *BT:* USB
Form Factor	Half Size Mini Card
Data Rate	**802.11b:** 11, 5.5, 2, 1 Mbps;**802.11g:** 54, 48, 36, 24, 18, 12, 9, 6 Mbps **802.11n:** - MCS 0 to 15 for HT20MHz; - MCS 0 to 15 for HT40MHz **802.11ac:** - MCS 0 to 8 for HT20MHz; - MCS 0 to 9 for HT40MHz; - MCS 0 to 9 for HT80MHz
Media Access Control	**WiFi:** CSMA/CA with ACK **WiFi + BT:** AFH, Time Division

Modulation Techniques	**802.11b**:CCK, DQPSK, DBPSK **802.11a/g/n**:64 QAM, 16 QAM, QPSK, BPSK **802.11ac**:256QAM, 64 QAM, 16 QAM, QPSK, BPSK **BT**:GFSK, p/4 DQPSK, 8DPSK
Network Architecture	**WiFi**:

	Ad-hoc mode (Peer-to-Peer) Infrastructure mode
Operating Chann el	**BT 2.4GHz:** Ch. 0 ~78**WiFi 2.4GHz:** 11: (Ch. 1-11) – United States 13: (Ch. 1-13) – Europe 14: (Ch. 1-14) – Japan **WiFi 5GHz:** 20MHz band width : - Ch 36, 40, 44, 48, - Ch 52, 56, 60, 64, - Ch 100, 104, 108, 112, 116, 120, 124, 128,132,136, 140, - Ch 149,153, 157,161, 165. 40MHz band width : Ch 38, 46, - Ch 54, 62, - Ch 102, 110, 118, 126, 134, - Ch 151, 159. 80MHz band width : Ch 42 - Ch 58 - Ch 105, 122 - Ch 155.

Frequency Range	• 2.400GHz ~ 2.4835 GHz • 5.1500GHz ~ 5.3500GHz • 5.4700GHz ~ 5.7250GHz • 5.7250GHz ~ 5.8500GHz
Security	• **WiFi** : WPA, WPA-PSK, WPA2, WPA2-PSK, WEP 64bit & 128bit, IEEE 802.11x, IEEE 802.11i • **BT:** Simple Paring
Operating Voltage	3.3 V ±9% I/O supply voltage

Industry Canada Statement

|This device complies with RSS-210 of the Industry Canada Rules.

- (The user manual of transmitter devices equipped with detachable antennas shall contain the following information in a conspicuous location:)
- This device has been designed to operate with an antenna having a maximum gain of 5 dBi. Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

CAN ICES-3 (B)/NMB-3(B)

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotopically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

IMPORTANT NOTE:

IC Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled

environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Caution: (DFS band usage-full bands)

1. the device for operation in the band 5150-5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
2. the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall comply with the e.i.r.p. limit; and
3. the maximum antenna gain permitted for devices in the band 5725-5825 MHz shall comply with the e.i.r.p. limits specified for point-to-point and non point-to-point operation as appropriate.
4. Users should also be advised that high-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.
5. Dynamic Frequency Selection (DFS) for devices operating in the bands 5250- 5350 MHz, 5470-5600 MHz and 5650-5725 MHz

This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2. This device and its antenna(s) must not be co-located with any other transmitters except in accordance with IC multi-transmitter product procedures. Referring to the multi-transmitter policy,
multiple-transmitter(s) and module(s) can be operated simultaneously without reassessment permissive change.
3. For all products market in Canada, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change.

- As long as 3 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.
- The device could automatically discontinue transmission in case of absence of

information to transmit, or operational failure. Note that this is not intended to prohibit transmission of control or signaling information or the use of repetitive codes where required by the technology.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the IC authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate IC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 6317A-RTL8821AE

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 6317A-RTL8821AE

Japan Statement

Host system must be labeled with "Contains MIC ID :xxxxxx", MIC ID displayed on label.

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N o.	Brand	Ant . Ty pe	Co n. Typ e	Peak Gain (dBi)		Model No.
				2.4GHz	5GHz	

01	LYNwave	PIFA	IPEX MHF4	TX1: 3.5	5	TX1: ALA110-222050-300011
02	LYNwave	PIFA	IPEX	TX1: 3.5	5	TX1: ALA110-222050-300010
03	JOYMAX	DIPOLE	IPEX	TX1: 3.0	5	TX1: TWF-614XMPXX-500
04	Realtek	SLOT	IPEX	TX1:3.33	4.52	TX1: PANT 001
05	Realtek	SLOT	IPEX MHF4	TX1:3.33	4.52	TX1: PANT 002
06	Well Green	PIFA	IPEX	TX1: 0.85 TX2: 0.44	0.751.24	TX1: SKW10WMPB01+A TX2: SKW10WMPB02+A
07	Well Green	PIFA	IPEX	TX1: 0.42 TX2: -0.13	0.111.27	TX1: SK65EWMPB01+A TX2: SK650WMPB02+A
08	JESS-LINK	PIFA	IPEX	TX1: 2.72 TX2: 0.07	1.520.91	TX1: DC33001AD00 TX2: DC33001AD00
09	HIGH-TEK	PIFA	IPEX	TX1: -0.93 TX2: 0.87	1.480.96	TX1: DC33001AC00 TX2: DC33001AC00
10	Luxshared	PIFA	IPEX	TX1: 2.08 TX2: 0.14	3.62-1.91	TX1: L01RF019-DT-R (31-502717)TX2: L01RF021-DT-R (31-502716)

11	Well Green	PIFA	IPEX	TX1: 0.55 TX2: 1.36	1.263.74	TX1: SKAEUWMPB01+B TX2: SKAEUWMPB01+B
12	Well Green	PIFA	IPEX	TX1: 0.82 TX2: -2.23	0.942.18	TX1: SKA91WMPB02+A TX2: SKA91WMPB01+A
13	Wgt	PIFA	IPEX	TX1: 2.14 TX2: 1.92	1.722.65	TX1: W550EU WM-1 TX2: W550EU WM-2
14	Acon	PIFA	IPEX	TX1: -0.63 TX2: -3.39	-0.710.12	TX1: APP6P-700781 TX2: APP6P-700782
15	Acon	PIFA	IPEX	TX1: -0.13 TX2: -0.23	1.34-0.63	TX1: ATM6P-70100 TX2: ATM6P-70200
16	WNC	PIFA	IPEX	TX1: -0.58 TX2: -1.48	-0.67-0.47	TX1: DQ6G15G5800 TX2: DQ6G15G5700
17	Zhan Yun	PIFA	IPEX	TX1: -0.70 TX2: -1.20	-0.130.80	TX1: DQ60QTLI200 TX2: DQ60QTLI201
18	WNC	PIFA	IPEX	TX1: 1.15 TX2: 0.59	-0.51-0.04	TX1: 81.EKG15.G30 TX2: 81.EKG15.G29
19	YAGEO	PIFA	IPEX	TX1: 0.59 TX2: 0.90	0.350.95	TX1: CAN4313LC0613WLA3 TX2: CAN4313LC0613WLA4
20	WNC	PIFA	IPEX	TX1: 0.18 TX2: 0.60	1.921.50	TX1: 81.EKG15.G38 TX2: 81.EKG15.G37
21	JESS-LINK	PIFA	IPEX	TX1: 1.89 TX2: 1.56	-0.07-0.09	TX1: PANT11A00008-1 TX2: PANT11A00009-1
22	Foxconn	PIFA	IPEX	TX1: 0.21 TX2: 0.60	1.23-0.36	TX1: WDAN-T1RH1 TX2: WDAN-T1RH2

23	Well Green	PIFA	IPEX	TX1: 0.21TX2: -0.75	1.651.15	TX1: SKX71WMPB01+B TX2: SK370WMPB01+B
24	Luxshared	PIFA	IPEX	TX1: -0.6TX2: -0.29	0.740.98	TX1: L01RF008-R TX2: L01RF009-R
25	Well Green	PIFA	IPEX	TX1: 0.72TX2: 0.49	-0.72-0.71	TX1: SKW25WMPB01+A TX2: SKW25WMPB01+A
26	Well Green	PIFA	IPEX	TX1: -0.17 TX2: -2.24	-0.130.03	TX1: SK549WMPB01+A TX2: SK549WMPB02+A
27	Wgt	PIFA	IPEX	TX1: 1.7	2.2	TX1: W350ETQ WM-1

				TX2: 2.53	2.78	TX2: W350ETQ WM-2
28	Well Green	PIFA	IPEX	TX1: -1.93 TX2: -1.28	-1.131.08	TX1: SKW54WMPB01+C TX2: SKW34WMPB02+A
29	Joinsoon	PIFA	IPEX	TX1: 2.6TX2: 0.53	2.612.60	TX1: IA-120266 TX2: IA-120267
30	WNC	PIFA	IPEX	TX1: 0.24TX2: -0.58	2.85-0.16	TX1: 25.90AH8.001 TX2: 25.90AH7.001
31	Wieson	PIFA	IPEX	TX1: 1.28TX2: 0.34	3.842.60	TX1: 25.90AH8.011 TX2: 25.90AH7.011
32	Yageo	PIFA	IPEX	TX1: -0.27 TX2: -0.88	1.420.33	TX1: 25.90AH8.021 TX2: 25.90AH7.021
33	Yageo	PIFA	IPEX	TX1: -0.11 TX2: -0.68	0.420.34	TX1: 25.90AJB.001 TX2: 25.90AJC.001
34	Yageo	PIFA	IPEX	TX1: -1.32 TX2: -1.14	2.941.89	TX1: 25.90AJB.001 TX2: 25.90AJC.001

35	Yageo	PIFA	IPEX	TX1: 2.74 TX2: 0.63	0.070.46	TX1: 25.90ALR.001 TX2: 25.90ALQ.001
36	WNC	PIFA	IPEX	TX1: -0.61 TX2: 1.91	2.23-0.40	TX1: 25.90AAL.001 TX2: 25.90AAK.001
37	TE Connectivity	PIFA	IPEX	TX1: 1.29 TX2: 0.04	1.251.08	TX1: 25.90AAL.011 TX2: 25.90AAK.011
38	HIGH-TEK	PIFA	IPEX	TX1: -2.20 TX2: -2.20	0.10.7	TX1: 25.90ALR.011 TX2: 25.90ALQ.011
39	HIGH-TEK	PIFA	IPEX	TX1: -0.70 TX2: -0.60	0.550.14	TX1: 25.90AJB.011 TX2: 25.90AJC.011
40	HIGH-TEK	PIFA	IPEX	TX1: -0.42 TX2: 1.59	2.27-0.05	TX1: 25.90AJB.011 TX2: 25.90AJC.011
41	ACON	PIFA	IPEX	TX1: 0.96 TX2: 1.33	1.271.61	TX1: ATP6P -700000 TX2: ATP6P -700001
42	INPAQ Technology	Dipole	IPEX	TX1: -1.1 TX2: 0.45	1.59-0.02	TX1: DAM-14-H-DB-800-10-17 TX2: DAM-14-H-DB-800-10-17
43	Well Green	PIFA	IPEX	TX1: 1.05 TX2: -0.41	1.082.32	TX1: SK110WMPB01+A TX2: SK110WMPB02+A
44	Well Green	PIFA	IPEX	TX1: -1.61 TX2: -2.84	-0.14-0.96	TX1: SKW23WMPB01+A TX2: SKW23WMPB02+A
45	Well Green	PIFA	IPEX	TX1: -0.93 TX2: 0.20	0.960.86	TX1: SK740WMPB01+A TX2: SK740WMPB02+A

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USING THIS DOCUMENT

- This document is intended for the software engineer's reference and provides detailed programming information.
- Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide.

REVISION HISTORY

Revision	Release Date	Summary
0.1	2013/1/28	Preliminary release.

Warning

FCC STATEMENT

Federal Communication Commission Interference Statement
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed

and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

IMPORTANT NOTE

FCC Radiation Exposure Statement:

- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.
- Operations in the 5.15-5.25GHz band are restricted to indoor usage only.
- IEEE 802.11b or 802.11g operation of this product in the U.S.A. is firmware-limited to channels 1 through 11.

This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and

2. This device and its antenna(s) must not be co-located with any other transmitters except in accordance with FCC multi-transmitter product procedures. Refering to the multi-transmitter policy,

   multiple-transmitter(s) and module(s) can be operated simultaneously without C2P.

3. For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change. As long as 3 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: TX2-RTL8821AE".

Manual Information To the End User

- This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated.
- Additional testing and certification may be necessary when multiple modules are used.
- Devices will not permit operations on channels 120-132 for 11a and 11n/a which overlap the 5600 – 5650 MHz band.

Realtek Semiconductor Corp.

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Frequently Asked Questions

- **Q: Can the product be used in outdoor environments?**
  - A: No, installation on outdoor fixed infrastructure and operation on oil platforms are prohibited.
- **Q: What temperature range should the product be stored in?**
  - A: The product should be stored in temperatures ranging from -55°C to +125°C.
- **Q: Are there any specific requirements for host integration?**
  - A: Yes, the product is designed for use with NGFF M.2 2230 PCIE Bus. Make sure to install the module correctly into a compatible slot.

Documents / Resources

	REALTEK RTL8922AE Combo Module [pdf] User Manual TX2-RTL8922AE, TX2RTL8922AE, rtl8922ae, RTL8922AE Combo Module, RTL8922AE, Combo Module, Module

References

- User Manual

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